

Theoretical and Experimental Aspects of Nanotubes as Hydrogen Storage Devices

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ABSTRACT

CO₂ emission accounts for 64% of *global warming*. The average earth temperature has risen by 0.6 °C. The sea levels are rising day-by-day, the snow cover is decreasing, and the draught frequency is increasing. These are few ill effects of global warming. The *Intergovernmental Panel on Climate Change (IPCC)* indicates that temperatures have risen due to increased *greenhouse gases*. If things continue like this experts predict a horror story for future generations. We cannot let this problem go out of control. There is a need to reduce dependency on fossil fuels. The energy crisis of mid-1970's led to the exploration of renewable energy alternatives, as people realized the risks of using fossil fuels. Above all we need to go for *cleaner technologies*.

Any renewable energy system that produces electrons should be connected to the infrastructure to directly reduce CO₂ emission from current fossil fuel generation and to avoid construction of additional fossil fuel power plants. One such infrastructure is the *fuel cell vehicle* in which chemical energy of hydrogen is converted into electrical energy by fuel cell, and the waste produced is water. Hydrogen can replace fossil fuels as an efficient energy carrier for transportation and electrical generation when renewable energy is not available. But hydrogen fueling infrastructure does not exist. This study is a small step in developing such infrastructure by use of nanotubes as hydrogen storage medium. The main advantage of the hydrogen storage technology is that it is portable and hence can be carried in a vehicle. Nanotubes are made up of graphite and fullerenes and store hydrogen by adsorption. This study focuses on the modeling and design of nanotubes for hydrogen storage, so that it can store maximum amount of hydrogen at ambient temperatures and pressures. But to model a system, the basic understanding of the physics of the system is essential.

This paper deals with an in-depth study on various hydrogen storage technologies, carbon nanotubes theory and experimental production methods, hydrogen storage in nanotubes, and modeling aspects of nanotubes. There are many hydrogen storage technologies like

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hydrogen storage as liquid/gas, metal hydride, hydrogen storage in graphites, zeolites, fullerenes, glass spheres and nanotubes. The advantages and disadvantages of these technologies and the problems faced while storing hydrogen are discussed. The types and categories of nanotubes are dealt with. The design of various types of nanotubes by using chiral vector is discussed. Properties of nanotubes are explained and their applications in various fields like electronics, mechanical and energy discussed. Various production methods of nanotubes which include electric arc method, laser ablation methods, and the chemical vapor deposition based methods are discussed and compared. The post treatment of nanotubes, which includes purification, alignment, characterization and functionalization is discussed. Light is also thrown on the growth mechanism of nanotubes during their production. The mechanism by which hydrogen is stored in the nanotubes and how the stored hydrogen can be extracted from the tiny tubes are discussed in detail. Doping of nanotubes to increase their storage capacity is also dealt with, and includes the alkali doping as well as hydrogen storage at room temperature. A model based on various potentials is given. Various simulation methods used to solve models in the field of nanotechnology are described. The results obtained by them are reproduced, so that the system can be better understood.